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LONG RANGE SPY ROBOT USING DTMF TECHNOLOGY

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ABSTRACT

In order to keep abreast with the fast growing need of humans, robotics and automation plays a distinct role throughout. The paper presents a model which enables the controlling of the robot remotely via mobile phone through Dual Tone Multi Frequency (DTMF) decoder. DTMF is one of the most recent and advanced technology for of data transmission. It is more efficient and better than the Bluetooth and Wi-Fi in the sense that the range of DTMF is very large i.e. the devices can be operated through DTMF irrespective of the geographical location of the person controlling it; also DTMF is one to one communication unlike Bluetooth in which up to 7 devices can be paired and Wi-Fi where almost 10 devices can be thereby providing more security to the channel through which data is being transmitted. DTMF commonly finds its use in defense surveillance as well as call centers. The use of DTMF can be further extended by using this technology in day to day life, for example, for differently able person this can serve as their extended arm allowing them to monitor their homes from one place and even helping them to pick and hold things by surveillance .

Keywords: Airdroid, Atmega 8 Microcontroller,DTMF Decoder L293d Motor Driver IC

I INTRODUCTION

Earlier communication was restricted only to wired means but as the advancement took place, wireless communication came into picture. Wireless communication happened via Wi-Fi, Bluetooth, RF(Radio Frequency). Wireless Ethernet compatibility alliance was launched by Lucent in 1966 which was later rename as Wi-Fi alliance which defined the 802.11 standard for wireless communication. By 2000, Bluetooth incorporated devices were out in the market and in 2002, IEEE 802.15 standard was approved for Bluetooth technology. Above stated technology have some limitations concerning the range of communication i.e. devices can communicate only up to a certain distance only. Term DTMF was coined in 1963 by Bell Systems under the trademark “touch tone”. Eliminating the range and the security problems, a prototype is developed working on DTMF which is further explained in this paper.

With the aim to develop a high performance robot that can facilitate high speed, easy control and better accessibility, an algorithm was devised that provided a faster, reliable and accurate approach to realize such a

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model. Earlier the robots were controlled through wired networks but now to make robot more users friendly, they are framed to make user commanded work. Therefore, to attain the requirements we can use android as a multimedia to control the user friendly robot. To attain a wireless control of the robot a technology viz. DTMF is used. A phone call is made on the phone which is attached to the robot and the call is answered automatically. During the phone all, any key is pressed by the caller, a DTMF(dual tone multiple frequency) tone is generated which is decoded by the DTMF decoder in to a 4 digit binary number which is further fed as an input to the microcontroller. The distinct applications of this concept in such robot can be a smart phone controlled robots where the movement of the robot is controlled by a robot on the basis of android platform.

The design of our project facilitates the robotic movement using DTMF technology operated remotely

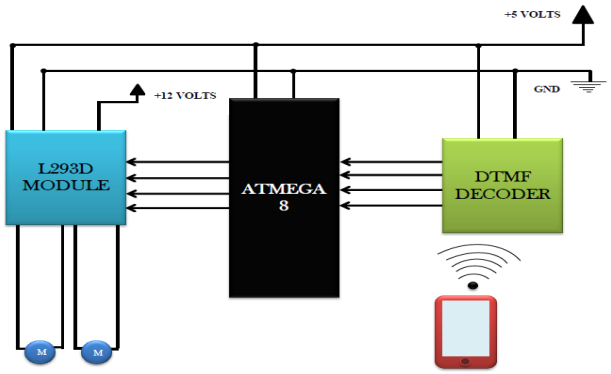

Fig.1. Block Diagram Of DTMF Based Robot

Component technologies used are

(a)DTMF technology

(b) C language

(c)Embedded system

II.DTMF TECHNOLOGY

DTMF was invented by Bell systems in 1963 as “Touch tone”. Before, DTMF pulse dialing were used by the telephone networks. Pulses were generated by clicking on the digits. The number of clicks represented he number. For example, for pressing 3, three clicks were made. Pulse dialing has the shortcoming that it can connect calls only for short distance and required an operator to connect distant call. Therefore, DTMF was introduced on November 18, 1963. Since then, pulse dialing was out of fashion and new customer telephone sets were introduced which incorporated DTMF circuitry.DTMF became the standard of telecommunication industry.

Dual Tone Multiple frequency tones are the combination of two superimposed sinusoidal waves. These tones were primarily used to transfer the calls through the exchange office but now they have several applications. Whenever, a key from the telephone is pressed, two frequencies are generated. Every key has a unique combination of two frequencies. One frequency is known as low frequency and another is known as high frequency.

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The each of the four rows on the dial pad is assigned a low frequency and each of the four columns is assigned a high frequency tone.The frequencies used are 697 Hz, 770 Hz, 852 Hz, 941 Hz for rows and 1209 Hz, 1336 Hz, 1477 Hz, and 1633 Hz for columns. Each frequency is carefully selected such that no frequency is the multiple of other frequency and no other frequency is obtained by adding or subtracting two frequencies. An error tolerance of 1.5% isassigned to each frequency generated [1].

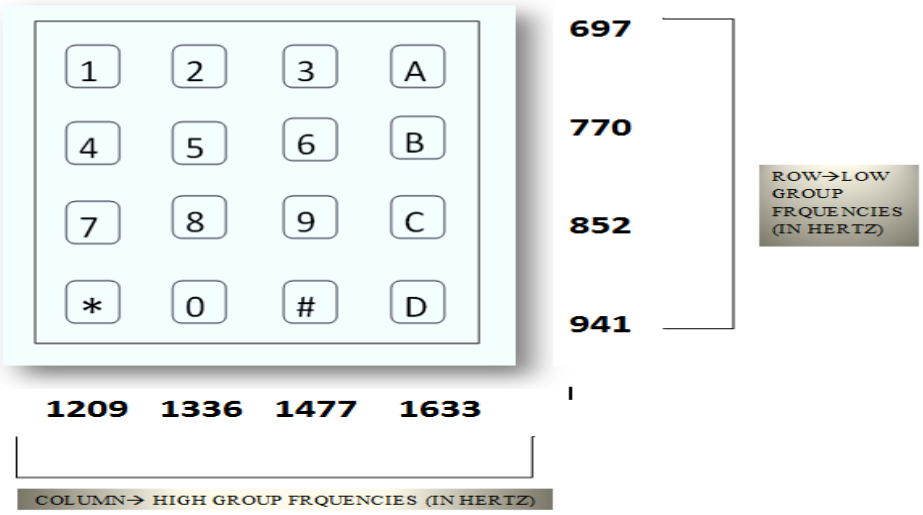

Fig.2. A Standard DTMF keypad [1]

If a key '4' is pressed the two tones of frequency 770 and 1209 Hz are produce simultaneously. These waves travel either via telephone lines or internet. A DTMF signal an neither be classified as an electrical signal or an audio signal. Initially, DTMF is an audio signal which is converted into an electrical signal and further converted in an electromagnetic signal during transmission. At the receiving end, the electromagnetic signal is again converted back into the electrical signal which is then transformed in an audible form.

Letters A,B,C,D are now obsolete and were basically used in military operations or had special functions.

DTMF technology has various advantages including security, easy to use, lesser error probabilities [1].

III.SOFTWARE DESCRIPTION

3.1. Atmel Studio

Atmel Studio, developed by ATMEL, provides an integrated development environment in order to develop program code into AVR MCU. It supports all AVR MCU and provides a powerful integrated development platform for its development [2].

It has a huge number of source code libraries which includes drivers and communication stacks and so provides easy debugging for code development into various AVR microcontroller chips. Along with it, it has a code editor which uses C/C++ level languages to build codes and to step over and step into its debugging processes [3]. Not only this, it too supports assembly level languages.

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3.2. Proteus(Proteus Design)

Proteus Design Suite is virtual schematic software that provides microcontroller simulation [4]. It is a tool for designing electronic systems and its simulation using Hex code generated from Atmel studio and thus provides user interface in generating prototypes, such as motor control and knowing output logic level 1 through its virtual LED connections for actual hardware implementation [5]. Above all, it makes the programmer to have an interface with his code by its virtual hardware design.

3.3. eXtreme burner

It is a software program which utilizes USB to transfer hex code into machine code to thespecified MCU through its SPI interface; this is done through a loader into which the machine code is first transferred.

3.4. Airdroid

Airdroid is a free & fast android app that lets you connect with phone from a web browser wirelessly & can be accessed from laptop/ PC. The range of this application is limited by the range on it is working for e.g. a normal households, it can be accessed upto100m without any obstruction & for large industries it can be 10 times. The Bot uses the Airdroid application to send video and one can access the surrounding of the robot in real time on the connected device whether PC or Laptop & one can easily do the surveillance. The major disadvantages are the PC/ Laptop should be using same network & there is delay in processing of image.[14]

IV. HARDWARE DESCRIPTION

4.1. ATMEGA 8

A microcontroller is a small sized single chip device also termed as tiny computers. Microcontroller is the control device of any robot. It is mainly used for the movement of the robot according to the user instructions. It also helps in controlling the transmission & reception of signal. In recent Era, there are various kinds of microcontroller families are available according to their applications like 8051, PIC (priority interrupt controller) & AVR (advanced virtual RISC) .[2]

ATmega8 is one of the widely used members of AVR family. It works on the frequency ranging up to 16 MHz and executes most of its instructions in single clock cycle. It has 8KB of flash memory, 512 bytes of EEPROM (electrically erasable programmable Read only memory). [1]Three internal Timers support both internal and external clocking. It supports both synchronous and asynchronous mode of data transfer using the USART (universal synchronous and asynchronous receiver and transmitter). USART is extensively used to established connection between a PC and microcontroller).[3]

4.2. L293D

L293D is a Motor driver IC which allows DC motor to drive in either direction. It works on the principle of H-bridge [9]. The H-bridge is a circuitry which consists of four switching elements with the load at center.

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[10]The switching elements Q1, Q2, Q3 & Q4 are usually bi-polar or FET transistors & the catch diodes D1, D2, D3 & D4 are usually of a Schottky type diodes. A L293D module has two h-Bridge circuit inside the IC which can rotate two dc motor independently [10]. The operating voltage range of L293D module is 4.5V to 36V. This module was designed to drive relays, solenoids, DC and bipolar stepping motors [11].

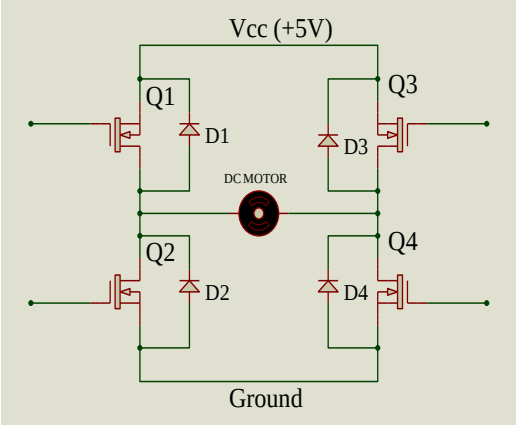

Fig.3. L293D basic architecture [10]

4.3. DTMF Decoder

The DTMF CM8870 decoder receives the tones transmitted by the caller & decodes them into a 4 bit code. This decoder uses a digital counting scheme to detect & decode all 16 possible tone pairs into 4 bit code [12]. The above shown figure is a complete

Module of DTMF decoder. The decoder IC has an inbuilt operational amplifier, the transmitted signals from phone are fed into inverting terminal of operational amplifier & the non-inverting terminal of operational amplifier is connected to reference voltage i.e. 5V. The pin 3 (Gain Select) is the outputof operational amplifier; a feedback signal is given to operational amplifier by connecting the output pin GS to inverting input through a resistor.

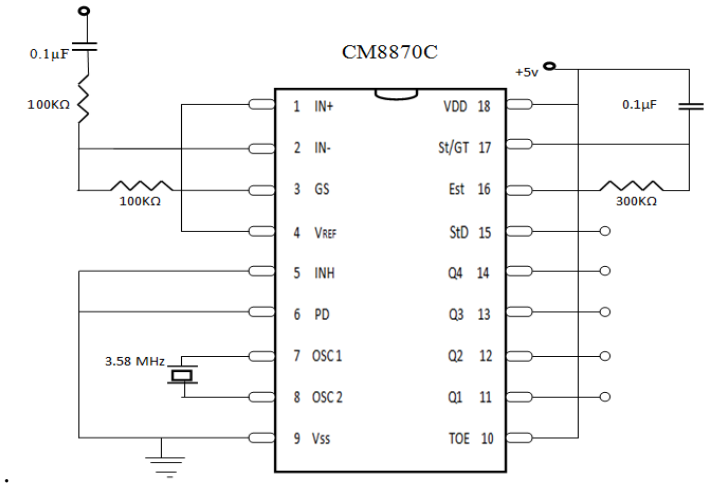

Fig.4.CM8870C DTMF decoder pin diagram [12]

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The output of internal Operational Amplifier is passed through a pre filter, which separates the low and high frequency signals. Next section is frequency detector circuit, which is used to detect the frequencies of the limited tones [12].

F_{LOW}	F_{HIGH}	KEY	D3	D2	D1	D0
697	1209	1	0	0	0	1
697	1336	2	0	0	1	0
697	1477	3	0	0	1	1
770	1209	4	0	1	0	0
770	1336	5	0	1	0	1
770	1477	6	0	1	1	0
852	1209	7	0	1	1	1
852	1336	8	1	0	0	0
852	1477	9	1	0	0	1
941	1336	0	1	0	1	0
941	1209	*	1	0	1	1
941	1477	#	1	1	0	0

Fig.5. Conversion Table

V.WORKING OF THE BOT

The working of bot includes 5 steps.

1. The mobile sends the signal in form of frequency whenever a key is pressed. The frequency generated to each tone is superposition of 2 different frequencies selected in such a manner that no two frequencies are integral multiple of each other.

2. After the frequency is transmitted from the mobile the DTMF decoder receives the signal decodes it according to the decoder table and correspondingly converts it into digital signal and sends the data to the microcontroller (in this case ATMEGA8).

3. The microcontroller is interfaced with DTMF decoder and it receives the output signal from the DTMF decoder at its PD0 to PD3 pins and according to the program loaded in the ATMEGA's ROM it sends the corresponding data at its output pins PC0 to PC3, which is connected to motor driver IC L293D.

4. The motor driver IC receives the data in form of logic high or low and accordingly rotates the motor with the logic. Logic high is positive 5 volts while logic low is 0 volts or ground.

5.Theairdroid app creates an intranetwork between the smartphone mounted on the bot and the laptop.It sends the real time video captured by the smartphone to the laptop as the bot traverses , therefore, getting the coverage

KEY	MOVEMENT	ATMEGA INPUT/DECODER OUTPUT	ATMEGA OUTPUT/ MOTOR INPUT
1	FORWARD	PDO	PC0
2	BACKWARD	PD1	PC1

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3	RIGHT	PD2	PC2
4	LEFT	PD3	PC3
ANY(EXCEPT 1,2,3,4)	STOPS		

Fig.6. Code Table

VI. ALGORITHM

The power is supplied by switching on the supply to all the connected devices i.e. Atmega8 and its peripherals.

1. A call is made from the transmitting end by the user.
2. The call gets automatically picked at the receiving end which is connected to dtmf decoder.
3. The user press a key from the keypad, which generates a unique frequency for corresponding key pressed and transmits it.
4. The receiving end mobile phone captures the signal and transmits to dtmf decoder; the decoder according to its defined logic converts that particular frequency into a digital signal and transmits the information to ATMega 8 microcontroller.
5. The microcontroller has a program stored in its ROM and it receives the signal from the decoder, and according to the signal received and logic defined in its code it generates a corresponding unique output which is transmitted to l293d motor driver IC.
6. The l293d IC receives the signal as logic high or logic low and correspondingly transmits positive 5 volts or ground to the pins connected to motors. The motor receives the corresponding signal and make the wheels rotate accordingly, thereby making the bot run.

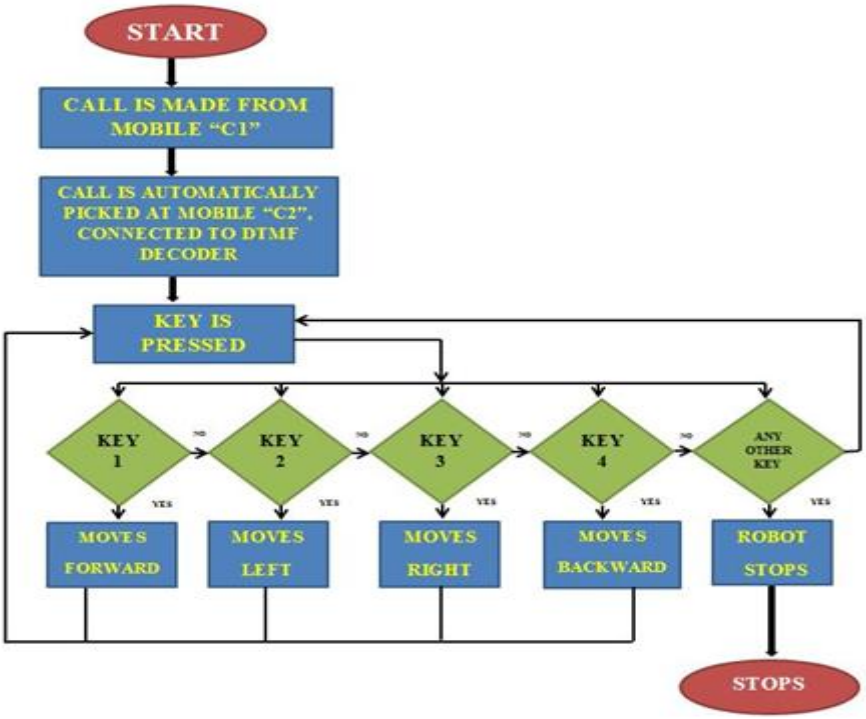

Fig.7. Flowchart of Algorithm

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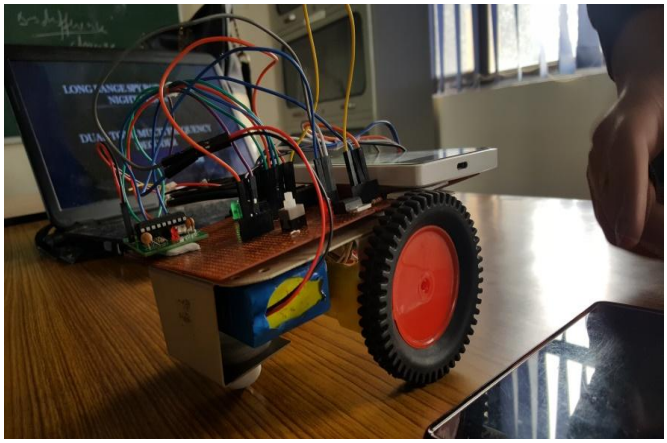
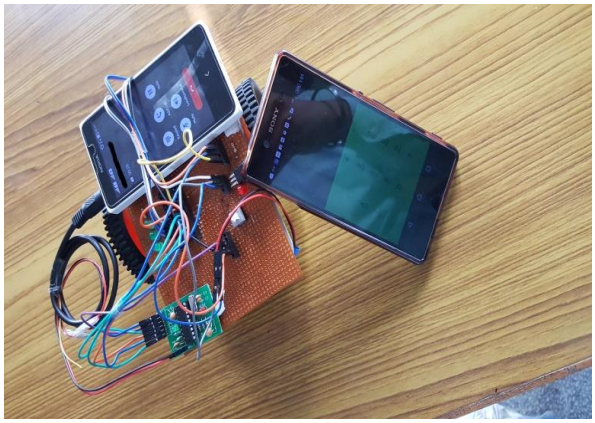
VII. ADVANTAGES AND COMPARISON

• Technologies like Bluetooth, WLAN, and Wi-Fi are limited in range unlike cellular technology that can be accessed over a wide range.

• Other technologies involve one to many communications unlike cellular technology that uses one to one communication thereby reducing the risk of security breach.





Long Range Robot Using DTMF Technology

VIII. APPLICATIONS

1. The robot can be used for the surveillance purposes and be deployed for use in military and spying areas.
2. The spy robot can be used for observing the behavior of wild animals where human beings can't reach.
3. The coverage of the disaster affected area can be obtained which are out of human's reach.
4. The spy robot can be used for the purpose of spying on enemy territories, tracking the location of their organization and then plan the action accordingly.
5. The prototype functionality can be further extended and can be used in many real times, real life applications. Extra features to help differently abled person can be included, an example of this can be, along with this bot doing surveillance, a robot arm can be incorporated to it for differently abled person helping them to bring different things like books, phones, glasses etc. Thereby, helping them and providing them with an extra support to live their lives more easily.

IX. FUTURE WORK

The system will include a spy wireless camera which is used to capture the area wherever the robot goes. All the area captured by this camera can be viewed in PC for reference.

X. CONCLUSION

Although wireless technology like Bluetooth, Wi-Fi or RF is a great leap in mode of communication for robots, the range up to which these wireless technology works efficiently in these cases is quite limited. To overcome this problem of range limitation of wireless communication we brought DTMF technology into the picture. As with

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DTMF we were able to marginalize the issue of constraints on range of the device up to which it can be accessed and we were able to access our bot from any range control it according to our commands successfully.

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